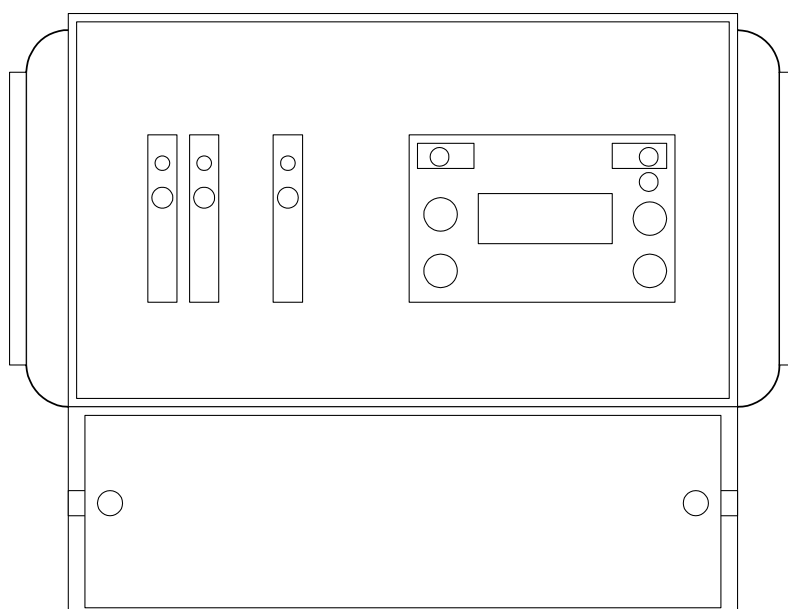




SOLAR SYSTEMS REGULATOR

DX 4132



User's guide

Námestovo, March 2002

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1 Introduction

Regulator DX4132 (in the next **regulator** alternatively **device**) is intended to regulation scheme consist of solar collector and two controlled loops, where heat exchanger take away thermal energy and transfer it to other scheme. Heat exchanger could be a boiler, swimming pool alternatively exchanger for heating object.

Regulator distributes warm-carrying liquid according to required temperature and priorities to separate loops by means of acting units (pumps and valves).

Device is equipped with timing facilities (programmable), which could use subsidiary energy source (electric heating alternatively gas kettle-drum), providing heat limitations in destination loop (electric heating can be externally out-of-work by high electrometer tariff).

Device uses the principle of comparing system parameters (requested, settings) "schedule" and measured ones. Requested parameters could be set with four keys and liquid crystal display (LCD) located on front panel. There could be found three-pole switches for automatic and manual running and LED diode signaling power line presence, the system fault and output relays state.

2 Control fundamentals

2.1 Regulation fundamentals

Regulator DX4132 is two-loop (two-channel) differential regulator. Controlled system consist of solar collector, two heat exchangers (A, B) and some actuating term, which distribute warm liquid to separate loops.

Regulator forever tests temperature in the given exchangers and compares it with the requested values (Fig.1). To pump warm liquid to exchanger must be fulfilled two conditions (in next text abbreviated **pump conditions**):

1. Insufficient heat exchanger temperature - measured exchanger temperature must be low than required temperature value (see "Menu-Temp"),
2. Sufficient energy in collector - collector temperature must be more than minimum difference "Delta" (see "Menu-Delta") than exchanger temperature. Parameter "Delta" is required because of thermal loss in piping between collector and exchanger.

Regulator at first tests loop with uppermost priority (see "Menu-Service-Priority"). In case pump conditions are fulfilled (exchanger has insufficient temperature and in collector has sufficient energy), this loop will be switched on e.g. warm liquid will be pumped through this loop (chap. 2.2). In case, only one condition is fulfilled alternatively none, regulator tests next loop according to destination priority. In case none loop has fulfilled conditions for pumping, all pumps will be off.

In case any loop have defined subsidiary energy source ("Menu-Service-El. heat) and exchanger have insufficient temperature, but collector will not have sufficient energy for this loop, it will be enabled subsidiary heating (chap. 2.4)

Loop priority defines, in what turn, warm liquid will be distributed to separate loops. So in case priority is e.g. "AB", uppermost priority have loop A, the least loop B, so regulator will find out pumping conditions at first in loop A, and in case they are fulfilled, switch on loop A, unless, tests loop B etc.

Loop priority is assigned in item menu "Service-Priority". Priority is defined for summer and for winter running (chap.2.6) separately.

2.2 Switching controlled loops

As DX4132 is two-circuit regulator, heat energy pumping is switched according to demand to separate loops. Device recognizes two different ways (modes) of loop switching for controlled system (see "Menu-service-Mode"), which differ in way of attached actuating terms:

- **Bar** - mode for system with 3-way valves - as actuating term are used: pump (P1) and 3-way valve (V1) (Fig.2) - activation of selected loop means switch valve and start pump P1. Pump is incorporated to output No.1, valve V1 to output No.2, For loop **A** output will be (on, off): 1-on, 2-off, **B**: 1- on, 2-on.
- **Point** - mode for system with independent pumps - for actuating terms two pumps are used (Fig.3) - activation selected loop means start pump in given loop (and break in other loop, in case it was before activated). Loop pump A is incorporated at output No.1, pump loop B is at No.2. For **A** loop output will be (on, off): 1-on, 2-off, **B**: 1-off, 2-on.

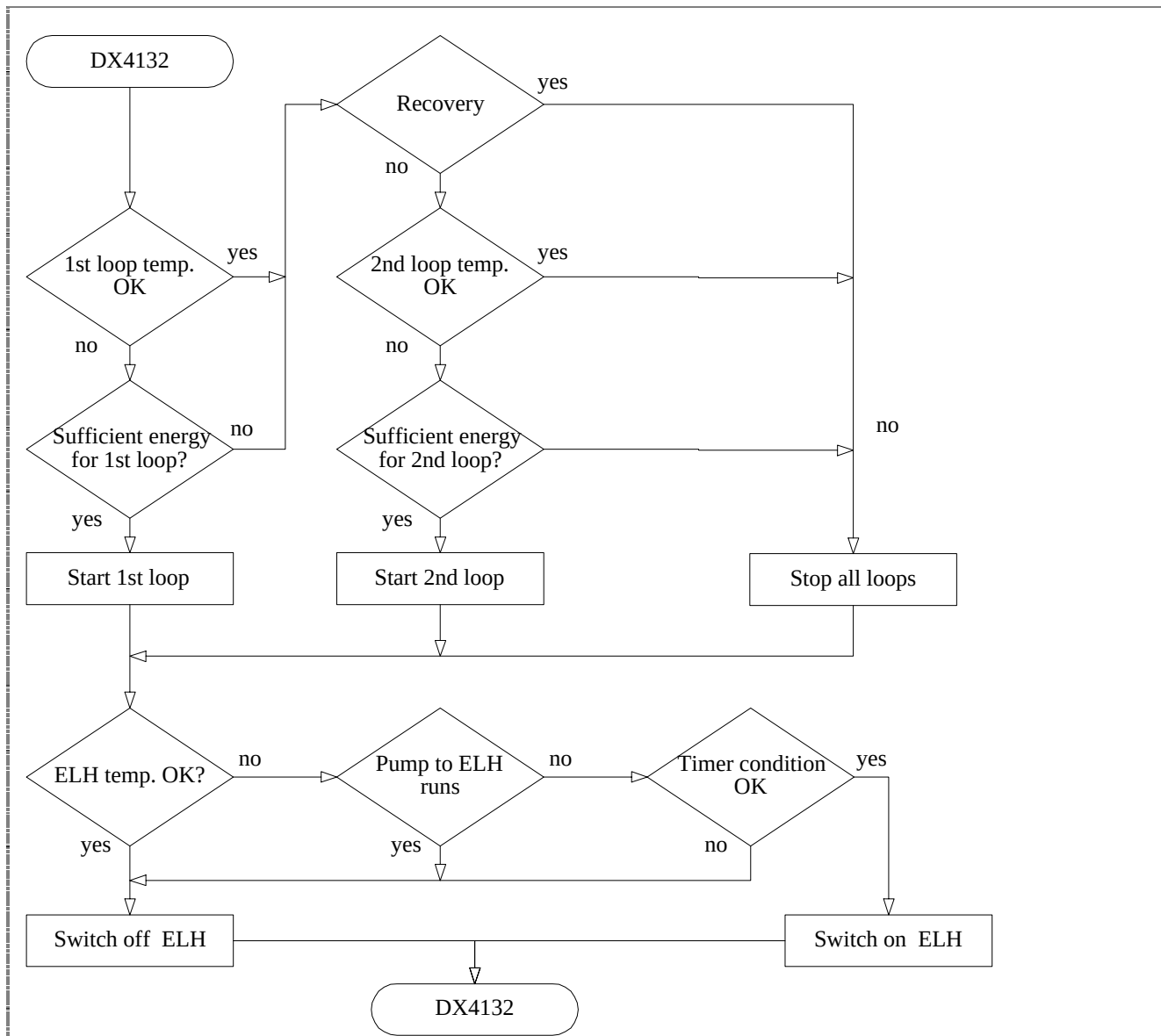


Fig.1 Algorithm of selecting loop and subsidiary heating. Loop 1 - loop with uppermost priority, loop 2 - loop with lowest priority, loop ELH - loop, for which is dedicated subsidiary heating.

2.3 Collector recovery function

Device is equipped with collector recovery function (which prevents under-cooling). In case some loop has low requested temperature value (compare to the loop with uppermost priority) and big accumulating ability (pool) and warm is pumped through this loop, it cools collector field, which afterwards can not reach temperature necessary to pumping warm to loop with most significant priority.

Function collector recovery is disabling warm pumping to loops with low priority at the beginning every hour for 5 minutes, but only while collector temperature is not "delta" more than requested temperature in loop uppermost priority.

Function collector recovery could be enabled or disabled in item menu "Service-Recovery".

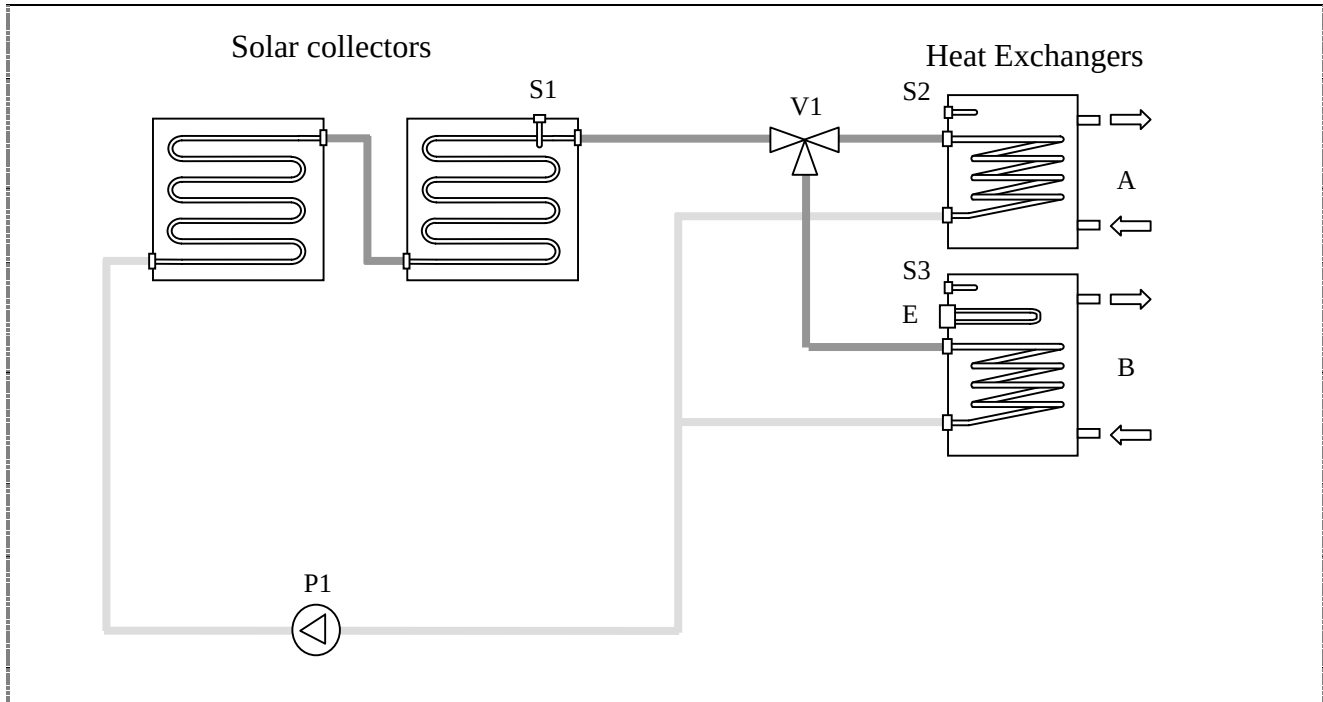


Fig.2 Block scheme of regulated system with 3-way valve: A,B - exchangers, S1,S2,S3 - temperature sensors, E - subsidiary electric heating, V1 - switching valve, P1 - pump

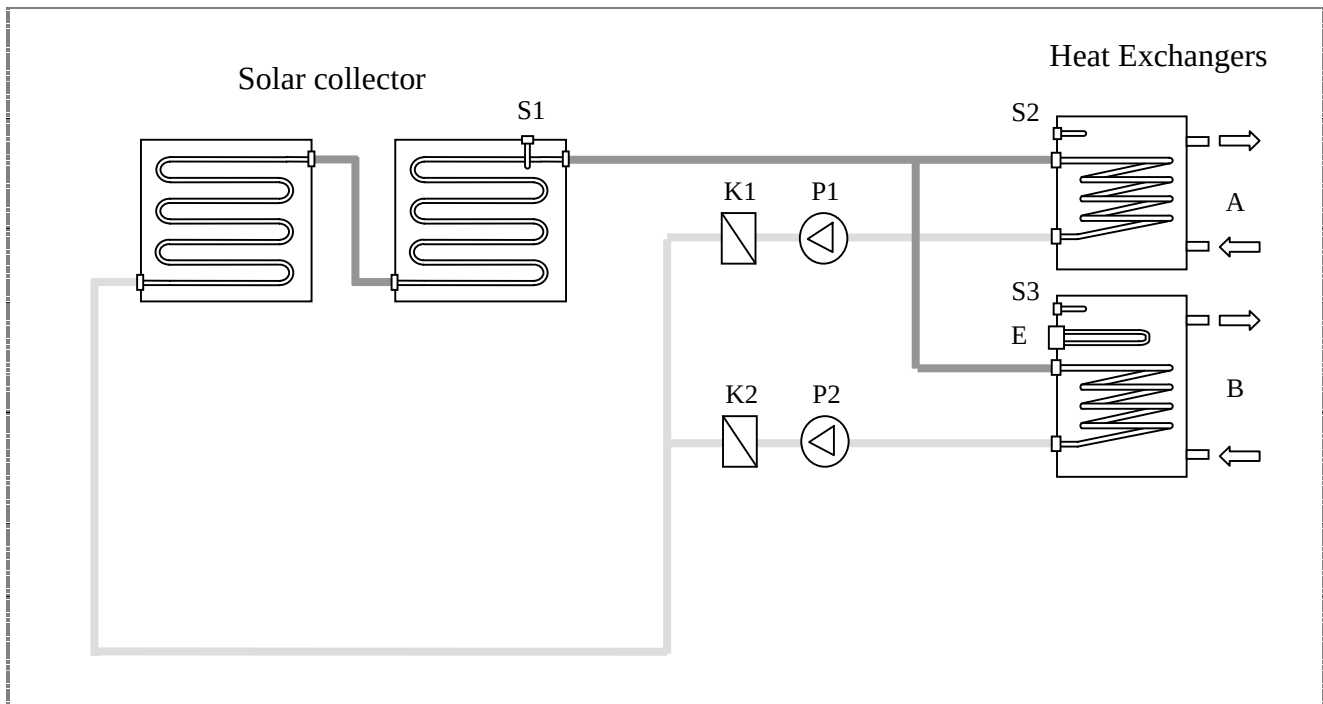


Fig.3 Block scheme of regulated system with separate pumps: A,B- exchangers, S1,S2,S3 - temperature sensors, E - subsidiary electric heating, K1,K2 - backward clamps, P1,P2 - pumps

2.4 Subsidiary energy source

Device has integrated equipped timing facilities ("Menu-Service-Timer"), which uses ranging subsidiary energy source (electric heating or gas kettle-drum) providing limitations warm in destination loop ("Menu-Service-El. Heat").

Subsidiary electrical heating will be on:

1. Providing some time condition is fulfilled in item "Timer"
2. Providing given exchanger have insufficient temperature, but collector has not sufficient energy for this loop or warm is pumped into loop with high priority.

In case none loop is chosen (i.e.. item El. Heat ='-'), output E will be switched only according to item "Timer", so is not fixed to demand from any loop.

Providing subsidiary heating will be set to manual, the heat will be not pumped from collector to the loop, which has set subsidiary heating!

In case subsidiary energy source is electric heating, that can be automatic out-of-operation by high electrometer tariff by predetermined digital input as ("Service - Typ. Inp "="HDO")

2.5 Collector temperature sensing

Collector temperature sensing is possible to execute in two ways, namely direct placement temperature sensor to collector corpus, or its placement on output pipeline, closest to collector (e.g.. at vacuum collectors). In this second case right temperature value could be examined only when the flow of the warm liquid from collector is established.

In case that, is not fulfilled condition to pumping (chap.2.1), regulator starts pumping liquid to loop with uppermost priority in setting period (item "service-Sensor-Pipe-per") for fixed time (item "service-Sensor-Pipe-on"), namely only providing variable "sunshine" - is set.

Value "sunshine" can be set in two ways:

- 1 In case digital input is set to "sunshine" (see "Service-Typ. Inp "=" sunshine") and that is short-circuited by sunshine (it is used sensor of illumination intensity),
- 2 In case digital input is not set as "sunshine" the time of sunshine is assigned according to 15th day of the current month: January 7:30-16:15, February 7:00-17:00, March 6:00-17:45, April 5:00-18:30, May 4:15-19:15, June 3:45-19:45, July 4:00-19:45, August 4:30-19:00, September 5:30-18:00, October 6:00-17:00, November 7:00-16:00, December 7:30-15:45. These values are approximate east and sunset times valid for middle of Slovakia. In case summer - time (chap. 3.2) addition 1 hour to these times is made e.g. for April sunshine time is from 6:00 to 19:30.

2.6 Summer and winter running

Choosing to summer or winter running is needed because of change of priority when selecting loop to pump warm. So providing some exchanger is dedicated for pool and second for heating object, in summer running pool will have priority and in winter heating.

Determination, whether summer or winter running is, define value "summer", which can be set in two ways:

1. In case to justify digital input as "summer" (see "Service-Ty. Inp "=" summer") and that is short-circuited (e.g. with. switch)
2. In case input is not set as "summer", it will be taken date from 1.May till 30.September

2.7 Failure reaction

In case occurrence sensor failure regulator responds in this way:

- failure of collector sensor or all loop sensors - warm carrying liquid is pumped always (till fault clearing) to loop with uppermost priority
- malfunction some loop sensor - given loop is not controlled (is skipped in algorithm to choose loop for pump and so-certainly is out-of-operation subsidiary heating, providing is dedicated for this loop)

3 Service

3.1 Device description

Regulator DX4132 has on front panel display (two lines for 8 characters), keyboard consist of four keys, 2 light indicators (PWR and ERR), push button RESET and tetrad output switches (Fig.4).

Through display and keys is possible to obtain regulation state review, find out measure values and requested values, edit these parameters, etc. Entrance to individual items is solved in form of menus.

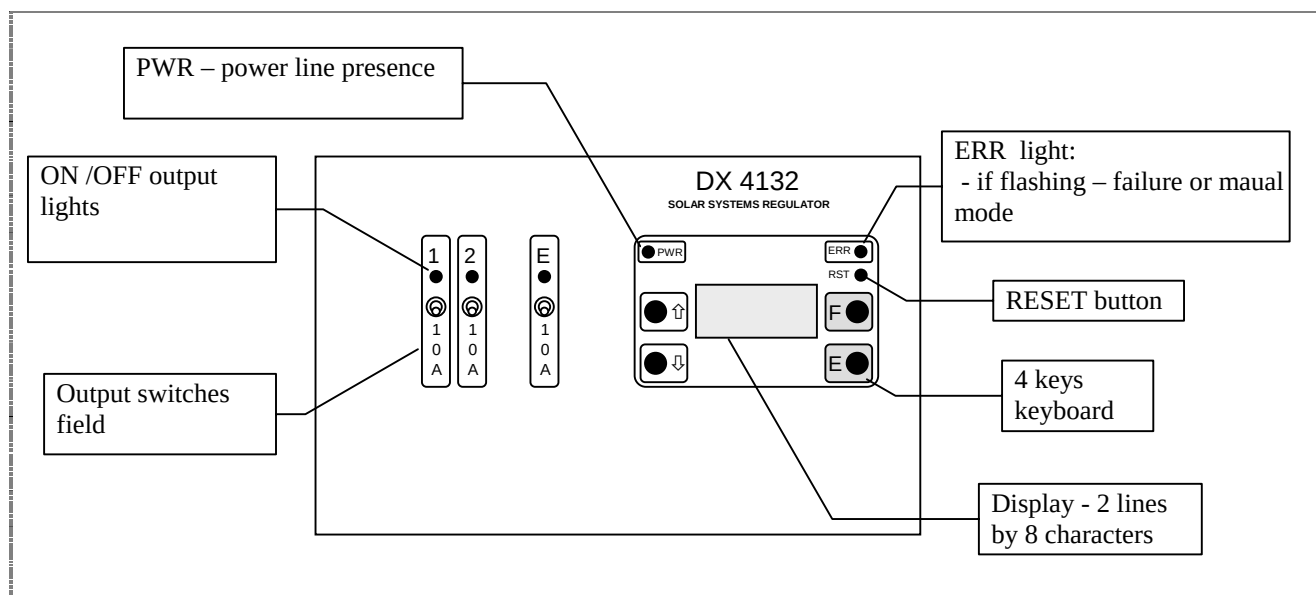


Fig.4 Front panel of DX4132

Keypad is made from four push buttons, which enable setting all parameters of controlled system. Meaning of individual keys:

- F ...** Function key - by change entry (editing), cancel changes (Escape) and return backward, in menus (one level up)
- E ...** Enter by editing parameters acknowledgement of validity set entry (Enter) - provide for safekeeping entry, and transfer on next item
- ↑ ...** Choosing items in given direction, after stroke addition by 1, after holding (for a second) quick value increasing
- ↓ ...** Choosing items in given direction, after stroke subtraction by 1, after holding (for a second) quick value decreasing
- ↑↓.** Arrows at the same time - setting minimal value for editing one

Above display of the regulator can be seen 2 light indicators (PWR and ERR), which indicates:

- PWR - presence of power line voltage
- ERR - system failure (ERR blinks) - sensor fault, manual mode or an internal regulator failure (chap.3.4)

On the right under light indicator ERR is push button RST - processor reset. This push button is hidden under front panel, so it could be reach only with the thin tool.

On the left side of the panel is located output switch field ('1','2','E'), it gives possibility to set each output in manual mode switch off, switch on or retain it in regulator overhead (position 'A'). Above switch field the relay status is marked with light indicator.

During entire regulation process DX4132 provides display of operating data on LCD in two windows. Arrow keys enable switching between these windows (Fig.5). Window description is in the chapter 3.3. After pressing "F" key sets up menu, where requested regulation parameters could be edited: date, time, and service parameters. Menu description is listed in the chapter 3.2.

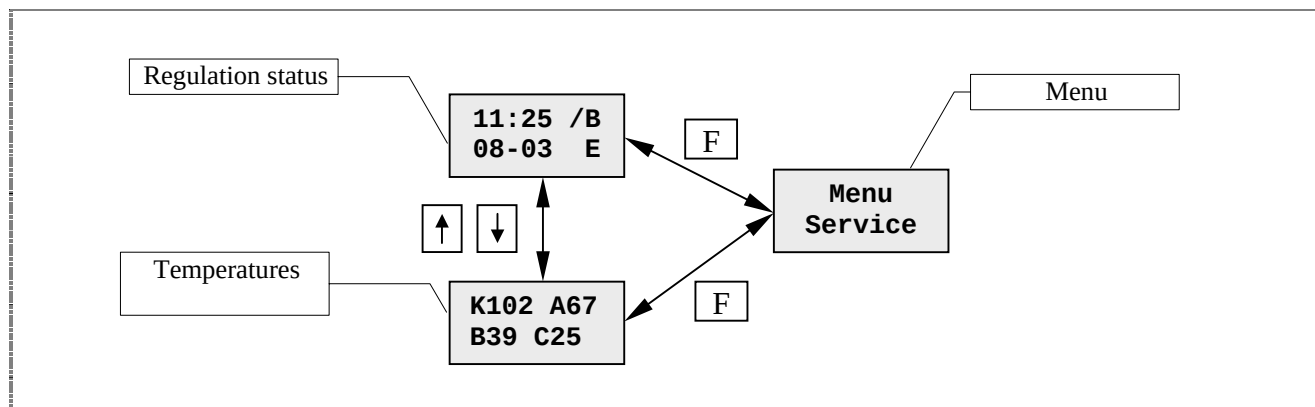


Fig.5 Switching between windows – status of regulation and menu

3.2 Menu structure

Menu could be reached by pressing (stroke) "F" key, in case the current display window is regulation status. Menu items are selected by ↑, ↓, keys and acknowledge selected item makes "E" key. "F" key quits current level and returns to the previous one. An edited item flashes. In case the edited value goes over maximum value, next will be the minimum and vice versa.

Menu items

In menu could be found these items:

- ◆ **Date** - Date setting. First day of the month, then month and in the end the year.
- ◆ **Time** - Time setting. First summer (light saving)(S) or CET (W) then hours and minutes.
- ◆ **Delta** - sets Delta value for all regulating loops (Kelvin)
Delta—minimal difference between collector and exchanger temperatures to pump warm from collector to exchanger.
- ◆ **Temp** - setting requested value for all regulating loops. (Celsius degree)
- ◆ **Service** - Service parameter editing.

Service settings

Accessing service settings could be seen in Fig.7. Service settings are parameters which are set once (at installation), so regulator asks for password to enter them. The password is number in format "ddhh", where dd is day of the month a hh is current hour (set in regulator). Service items are:

- ◆ **Sensor** - collector temperature location. There are two possibilities:
 - **Collector** - directly on collector corpus
 - **Pipe** - located at the output collector pipe (vacuum collector).
 When choosing this item an another window display where could be changed next parameters:
 - **per** - collector pumping period, because of temperature measuring (5,10,15,20 or 30 minutes)
 - **on** - time of collector pumping to get correct value (10 až 200 seconds).

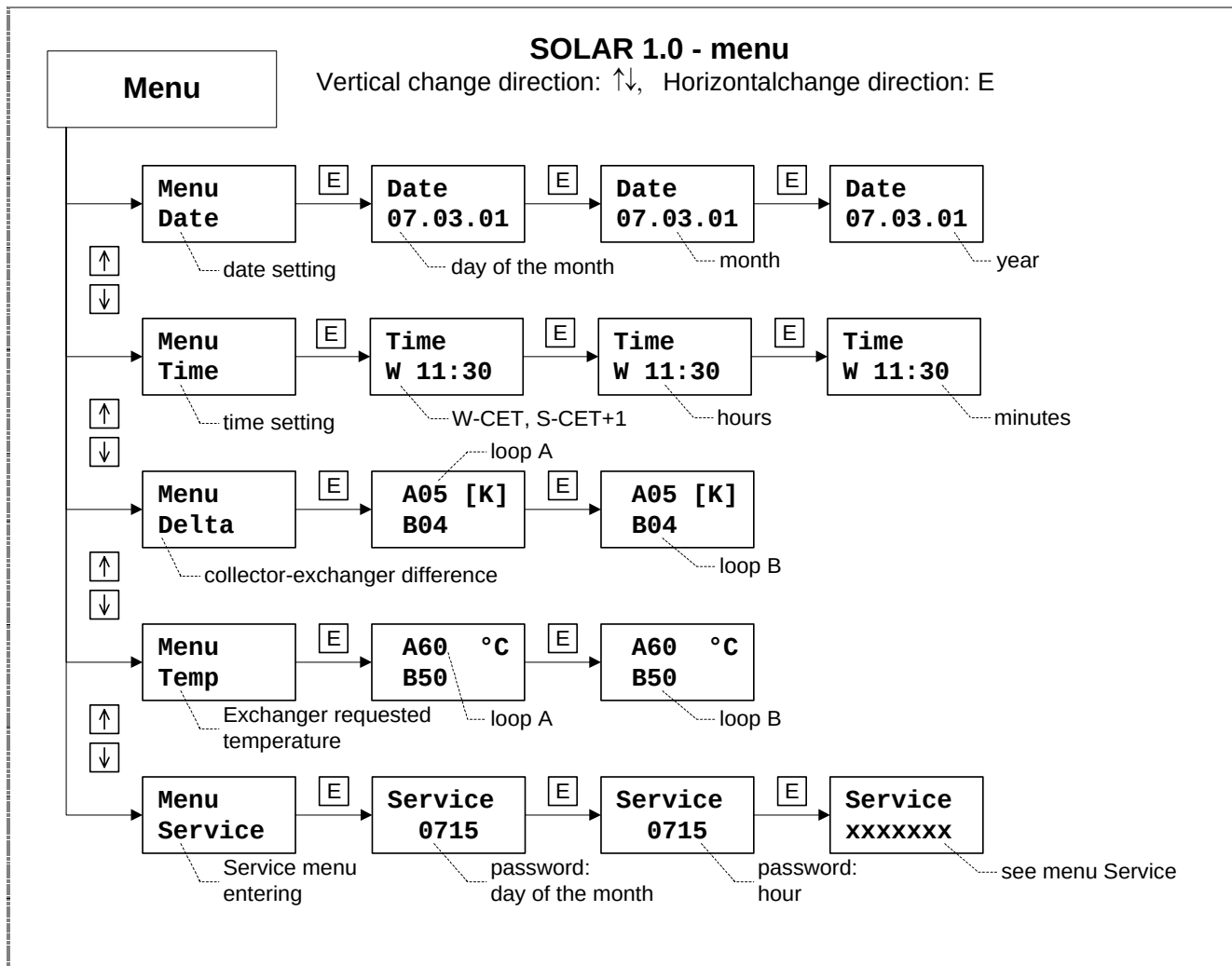


Fig.6 Accessing menu - menu Service could be found in Fig.7

♦ **Typ Inp** - digital input definition as:

- no use - not used
- sunshine - external sensor of light intensity
- summer - external switching between summer and winter running
- HDO - external disabling electrical heating during high tariff

♦ **Recovery** - enable or disable collector recovery function (Yes/No)

♦ **El.Heat** - electrical heating assigning to given loop ('-', 'A', 'B'),

Subsidiary heating starts if some time condition (item "Timer"), and if given heat exchanger has insufficient temperature or warm is pumped to another loop.

If no loop is selected output E will be controlled by "Timer" item.

♦ **Timer** - timer setting - maximum four time intervals during a day (0:00-23:59).

First switch on time, then switch off time. If there is a need to be switched during 23:59-0:00, switch off time should be set to 0:00.

♦ **Priority** - loop priority setting for ("S") and for ("W") "AB", "BA".

♦ **Out** - output type setting (concerns No. 1 and 2) – positive or negative (P/N)

If output is negative, it means output is turn on when appropriate LED is dark.

♦ **Mode** - loop switching mode. There are two possibilities:

- bar - bar mode of switching loops – for system with 3-way valve.

A need to turn the loop on starts pump and changes valve position.

- point - point switching mode - for system with separate pumps.

If there is a need to turn the loop on, pump start only in given loop the other stop. Only one in a time is allowed.

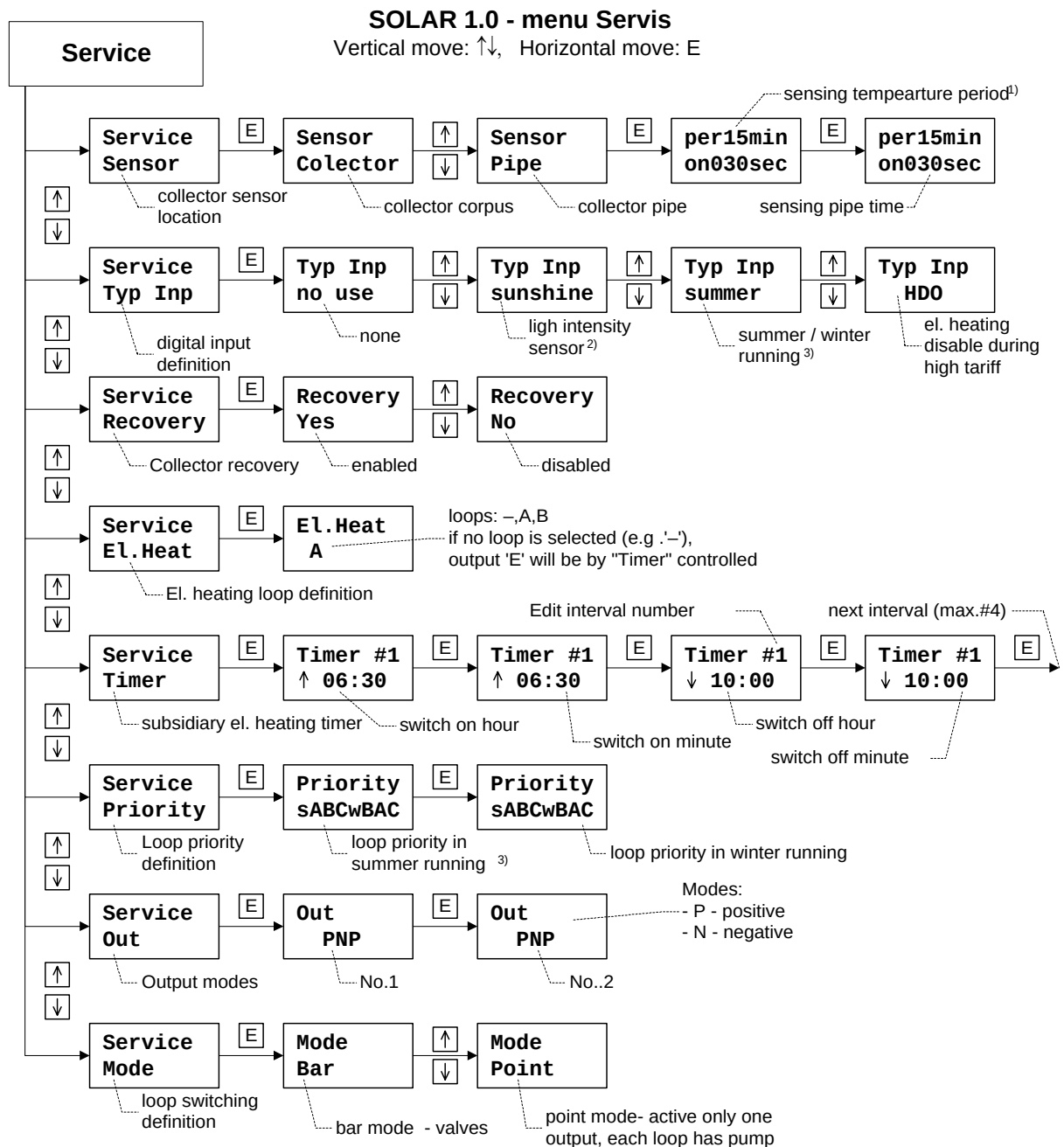


Fig.7 Menu Service

3.3 Control state displaying

Regulation status

In top line are displayed: time and loop state - if any loop is active, a rotation pump icon is displayed and name of loop (A, B or '?' providing ambiguity by manual shift). In case some output is at the position 1 or 0 (e.g. is in manual mode) and regulator can not control the loop, flashing 'M' appears at that position.

In low line are displayed: date, blinking sign 'p', in case regulator sense temperature at pipe, blinking sign 'r', in case recovery state, and sign 'E', in case subsidiary energy source is on.

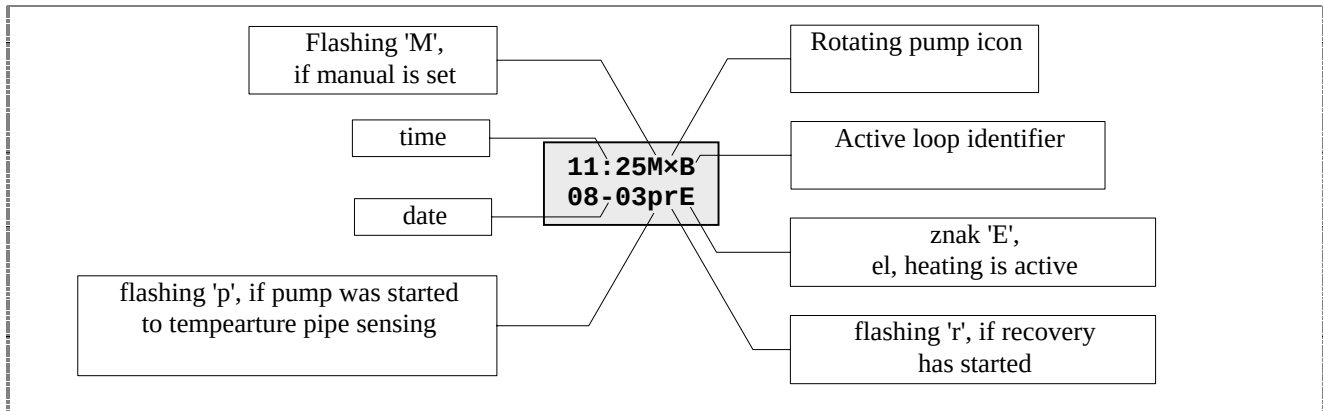


Fig.8 Regulation state display

Collector and loop temperatures

In top line collector and A loop temperature is displayed, in low line B loop temperature. In case sensor is short-circuited, flashing 'x' appear, in case sensor is disconnected flashing '-' appear and in case temperature is less or wider as predefined LCD value width allows flashing '9' appear.

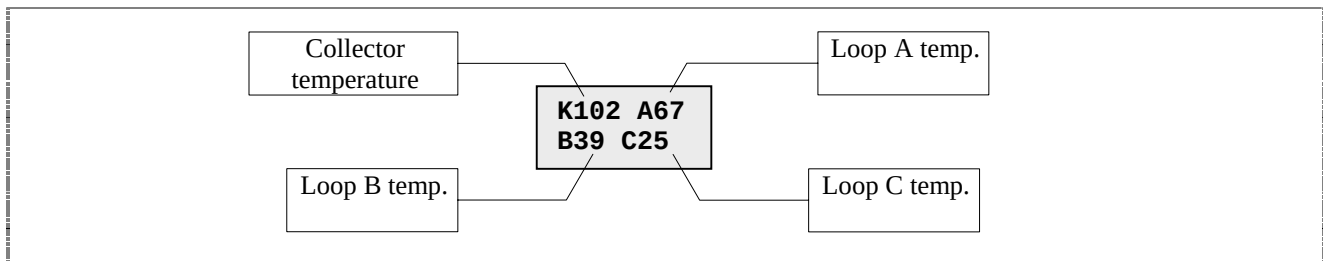


Fig.9 Temperature display format

3.4 Failure signaling

In case some failure or malfunction appear ERR indicator starts to blink. Regulator distinguishes three types of failures - system failure, sensor failure and manual mode.

Sensor failure: instead measured value "-" is displayed when sensor is disconnected, "x" - sensor is short-circuited, or "?" for converter malfunction.

Manual mode: in case regulation algorithm needs to start on required loop and it is not possible (some output is directly open or closed by switch), it is indicated as malfunction - at LCD in state regulation window "M" sign blinks.

System malfunction: converter malfunction - instead temperature values "?" are displayed, hour malfunction - instead time and date "?", are displayed output loop failure - instead pump icons and loop name "?" are displayed.

4 Installation advice

Regulation circuit consists: regulator DX4132, temperature sensors and power (actuating) terms (pumps, valves). Sensor and power terms are connected at regulator terminal field, which is located under protection box. Connector layout is listed at Fig.10.

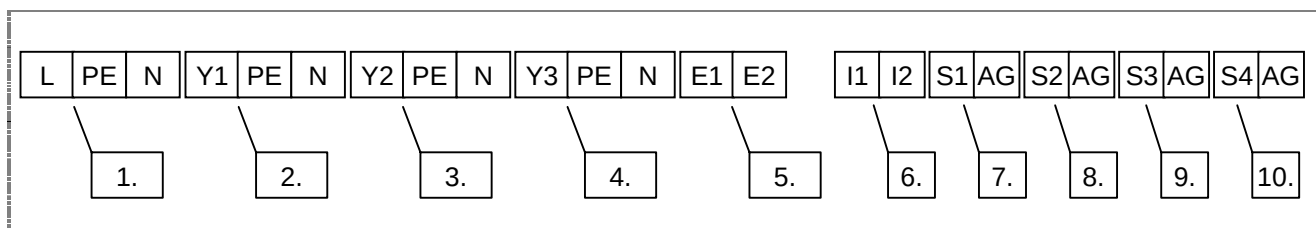


Fig.10 Terminal connections DX4132

Terminal name meaning (SV – switching valves, SP – separate pumps):

1. Power line supply 230V~/10A
2. output Y1 - SV: pump, SP: 1st loop pump
3. output Y2 - SV: valve No.1, SP: 2nd loop pump
4. output Y3 - not used
5. output E – make contact for subsidiary energy source (e.g. electrical heating)
6. digital input – using is set by software "Menu-Service-Typ Inp"
7. S1 – collector sensor
8. S2 - 1st loop heat exchanger sensor
9. S3 - 2nd loop heat exchanger sensor
10. S4 - not used

An installation DX 4133 should be made according to recommended application scheme (Fig.11), and take care with following rules:

- Just before power connection check all input and output wires (sensors, actuating terms) for disconnection or short-circuit,
- Before screwing wires to terminal, put the endings to the wires,
- Remove tit to fed wires In regulator box, fit insulation lead-through pieces and pass through all the wires,
- Firstly sensors, then actuators and in the end power line. For sensors is recommended twisted pair line (MK 2x0.75/TP 03/41/MTP 226/70), keeping distance from power wires (min.30 cm) a shield connect to PE wire.
- Turn on the fuse and test function of actuators in manual mode,
- Check measured temperature values at collector, then in the loops and set initial system parameters after go to automatic mode.

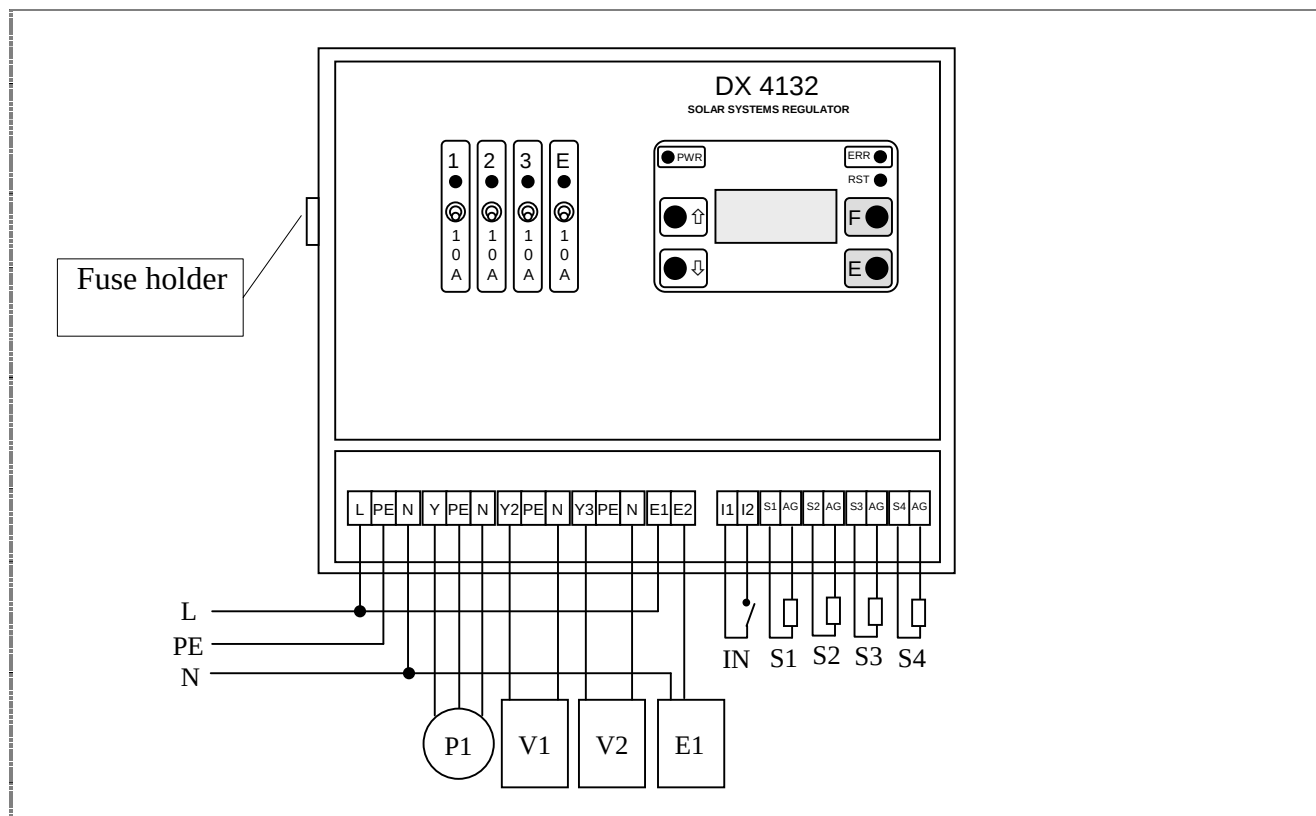


Fig.11 Application circuit for DX4132 3-way valves system: S_x – temp. sensors(KTY83), E – power relay, for 3 phase heating element, $P1$ - pump, $V1, V2$ - valves, IN – ON/OFF input, using is software defined "Menu-Service-Typ Inp"

5 Specifications

Technical data.

Power supply:	230V/50Hz
Max. dissipation:	500VA
Output voltage:	230V/50Hz
Max. output current:	2 A
Fuse:	2 A, type T
Temperature range:	-25 ÷ 200°C
Temperature sensors:	DX 1083 (DUEL Námestovo, 1000 Ohm @ 25°C, 1670 Ohm @ 100°C)
Differential range:	0 ÷ 12 K
Temperature accuracy:	± 1.5 °C
Back up:	time and date about 7 days, the other set in EEPROM memory

Operating ambient conditions.

Ambient temperature:	5 ÷ 50 °C
Air humidity:	max 90% @ 30°C
Air pressure:	70 ÷ 106 kPa

Warranty:

- Manufacturer provides guarantee 12 month from the day of delivery
- Warranty refers only on fault, which come into being by normal operation with sensor delivery. Do not refer to fault, which arises by inexpert service, incorrect storage, unsuitable environment and high power activity (spontaneous disaster, flood, fire, atmospheric discharge and so on.)
- User loses claim to warranty at devices, on those was execution hit
- Warranty also after-warranty service guards manufacturer.

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